Experience of Trauma on Overgeneral Autobiographical Memory: The moderating influence of cognitive load and heart rate variability

Research Thesis

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by

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ABSTRACT

Overgeneral autobiographical memory (OGM) is characterized by the recall of nonspecific and vague autobiographical memories in response to cue words in place of specific, episodic memories. Overgeneral memory has been linked to posttraumatic stress disorder. However, the relationship between experience of trauma and OGM in nonclinical samples has yet to be clearly established, with some studies suggesting a link and others finding no significant relationship. Because of these incongruent findings in the past, investigating the impact of moderators is important in understanding the relationship between experience of trauma and OGM. The current study investigates whether the links between a trauma history in a nonclinical population and OGM become more clear when the moderating impact of individual differences in inhibitory control or varying levels of cognitive load are considered. Participants were 300 college students (59% female, 68.5% Caucasian) who completed measures of OGM and experience of trauma and were placed under varying cognitive load conditions after an electrocardiogram recording was taken in order to assess resting heart rate variability (HRV), which provides a measure of inhibitory control capacity. Results indicate that HRV and cognitive load impact the association between experience of trauma and OGM such that OGM increases in individuals with a trauma history when they exhibit low HRV and when placed under high cognitive load.

INTRODUCTION

Background Information

Overgeneral autobiographical memory is a well-established phenomenon in which autobiographical memory specificity is reduced. Individuals exhibiting overgeneral autobiographical memory recall general knowledge about a type of event, instead of remembering the details of a specific event. Overgeneral memory is commonly measured with the Autobiographical Memory Test (AMT), which provides cue words for which participants recall memories for within a set time limit (Williams & Broadbent, 1986). Even when overtly instructed to recall specific memories and further prompted to do so, individuals exhibiting overgeneral memory recall nonspecific events. An example of overgeneral memory would be when an individual remembers that they are "always happy when visiting family" in response to the cue word "happy," instead of recalling something more specific such as "I was happy when I spent my birthday with my sister last month." Such categorical or extended memories (i.e., memories for events lasting more than one day) are both considered to be overgeneral, whereas an episodic memory of a single event occurring on a specific day is considered to be specific.

Overgeneral autobiographical memory has been linked to various clinical disorders, including major depressive disorder (e.g. Dalgleish et al., 2007) and posttraumatic stress disorder (PTSD; McNally Lasko, Macklin, & Pitman, 1995; McNally, Litz, Prassas, Shin, & Weathers, 1994). Evidence suggests that depression, including major depressive disorder and other forms of depression, is characterized by overgeneral memory (see Williams et al., 2007, for a review). However, the links between depressive symptoms and overgeneral memory in a nonclinical population are found only occasionally. Likewise, experience of trauma in the absence of posttraumatic stress disorder has been linked to overgeneral memory (e.g. Kuyken & Brewin, 1995; Sumner, 2012), but these links have not always been replicated (Williams et al., 2007, for a review) and this association remains unclear.

Experience of Trauma. Experience of trauma has been associated with many mental health disorders including anxiety, depression, and PTSD. Experience of trauma is commonly measured with the Life Events Checklist (LEC; Gray, Litz, Hsu, & Lombardo, 2004), which is a self-report measure of possible traumatic events. Experience of trauma has been linked to overgeneral memory in various studies, including those using nonclinical samples (e.g. Henderson, Hargreaves, Gregory, & Williams, 2002). Findings suggest that interpersonal trauma, such as childhood sexual abuse, is more likely to lead to overgeneral memory than other forms of trauma (e.g., automobile accidents; Aglan, Williams, Pickles, & Hill, 2010). However, significant links between experience of interpersonal trauma and overgeneral memory are not always found. For example, overgeneral memory was not found in a nonclinical sample of recovered burn patients (Willebrand et al., 2002). Experience of trauma has also been rejected as being predictive of overgeneral memory in a study using a clinical sample of depressed patients, with results suggesting that major depressive disorder and not the experience of childhood trauma (i.e. childhood abuse and neglect) was the significant predictor (Wessel, Meeren, Peeters, Arntz, & Merckelbach, 2001). This mixed pattern of results, with some studies finding a significant relationship and others failing to do so, currently lacks explanation and suggests that there could be underlying moderators driving the association between experience of trauma and overgeneral memory. The identification of these moderators is necessary in order to thoroughly understand the connection between trauma and overgeneral memory. Investigating the role of inhibitory control, a component of executive control, in this relationship may provide a significant moderator that explains the inconsistencies of past findings and clarifies the association between experience of trauma and overgeneral memory.

CaR-FA-X model (Williams et al., 2007). The most notable model outlining the mechanisms responsible for overgeneral autobiographical memory is the CaR-FA-X model, which includes Capture and Rumination, Functional Avoidance, and impaired eXecutive control (Williams et al., 2007). Whether each of these mechanisms is responsible for all cases of overgeneral memory, or for certain cases of overgeneral memory found within specific populations, remains unclear. Though attentional capture and rumination and impaired executive control are well supported as being mechanisms underlying overgeneral memory, there is some debate about whether functional avoidance should be included as a mechanism underlying overgeneral memory (Sumner, 2012). Though each of these mechanisms require further investigation, the CaR-FA-X model remains the most salient model of overgeneral memory to date, with impaired executive control being a well-established component of the model.

Executive control is involved in the regulation of cognitive functions including inhibition, reasoning, emotion regulation, and self-control. Deficits in executive control are thought to impair the ability to successfully retrieve specific memories (Sumner, 2012; Williams et al., 2007). Past research has indicated that executive control capacity influences AMT performance, independent of depressed mood, and, further, that executive control deficits mediate the link between depressed mood and overgeneral memory (Dalgleish et al., 2007; Raes et al., 2010). Resting heart rate variability can be used to provide an index of inhibitory control capacity.

Heart Rate Variability. Heart Rate Variability (HRV) refers to variation in the time interval between each heart beat due to vagal tone. Cognitive, affective, and autonomic regulation are influenced by physiological and neural systems whose relationship can be measured by HRV (Thayer & Lane, 2000). The neurovisceral integration model of emotion regulation and dysregulation demonstrates that tonic reduction in HRV interferes with self-regulatory processes via disrupted negative feedback circuits (Thayer & Lane, 2000). Consequently, greater tonic (i.e., resting) heart rate variability is viewed as being more adaptive, and a sign of greater cognitive and physiological health. Heart rate variability has been shown to have a positive relationship with executive control, which is accomplished via the vagus nerve, a nerve that provides a connection between the prefrontal cortex, the brain region associated with executive control, and the heart (Thayer, Åhs, Fredrickson, Sollers, & Wager, 2012). Moreover, studies suggest that memory suppression in a nonclinical population is achieved via the prefrontal cortex (Depue, Curran, & Banich, 2007). The relationship between HRV and the prefrontal cortex is such that higher prefrontal cortex activity is associated with greater executive functioning, both of which are associated with higher HRV. Specifically, it has been found that HRV can be used as a measure of inhibitory control because of the relationship between HRV and inhibitory pathways in the brain (Thayer & Lane, 2009). Furthermore, HRV has been linked to control over memory retrieval and inhibitory control over memory (Gillie, Vasey, & Thayer, 2014). Together, these findings suggest that the link between the prefrontal cortex and the heart provides the relationship between HRV and memory as well as between HRV and inhibitory control.

Cognitive Load. Past research indicates that when a nonclinical sample is placed under cognitive load, HRV acts as a moderator in the relationship between depressive symptoms and overgeneral memory, such that when participants are placed in a high cognitive load condition, low HRV in individuals with depressive symptoms is linked to increased overgeneral memory

(Feeling, 2015). This relationship was not found in nonclinical participants who were placed under a low cognitive load condition, suggesting the importance of cognitive load in bringing these links to the surface in a nonclinical sample. These findings suggest that the interaction between HRV and depressive symptoms may be used to predict the likelihood of overgeneral memory in a nonclinical population (Feeling, 2015). Similar relationships have not yet been investigated in individuals with a trauma history. Investigating the moderating relationship of HRV and cognitive load in the links between experience of trauma on overgeneral memory could clarify this relationship in a nonclinical population.

Hypothesis and Study Formation

Because clinical symptomatology has been correlated with executive control deficits (Dalgleish et al., 2007), and HRV has been linked to executive control over memory (Gillie, Vasey, & Thayer, 2014), it was predicted that there would be an interaction between HRV and experience of trauma on overgeneral memory, such that individuals with a trauma history and low HRV would show greater overgeneral memory than individuals with a trauma history and high HRV. The nonclinical sample used in this study was expected to exhibit less inhibitory deficits than a clinical population would, and therefore the influence of experience of trauma on overgeneral memory would only be evident in low HRV individuals, e.g. individuals with reduced inhibitory capacities. Because a nonclinical sample was used, interpersonal trauma experience was analyzed for this study, as it had previously been found to be more predictive of overgeneral memory than other types of trauma (Aglan et al., 2010).

In accordance with Feeling's (2015) study, it was predicted that a similar interaction between experience of trauma and cognitive load on overgeneral memory would be found.

Moreover, the interaction between low HRV and high cognitive load was expected to make the role of inhibitory control even more prominent by further depleting the already low inhibitory control capacities of these individuals. This current study sought to replicate the findings of Feeling's (2015) study, except with the replacement of depressive symptoms with experience of trauma. In line with past research, depression was explored as a covariate so that the unique influence of trauma experience on overgeneral memory could be determined.

Important implications for research on the moderating variables that influence the relationship of experience of trauma on overgeneral memory include better understanding the incongruity of past research and specifying the cases in which experience of trauma leads to overgeneral memory in a nonclinical population. Additionally, further investigation of the role of inhibitory control in overgeneral autobiographical memory provides a more detailed exploration of the executive control component of the CaR-FA-X model.

In order to test these hypotheses, we conducted a study looking at experience of trauma as an independent variable, overgeneral memory as a dependent variable, cognitive load and HRV as moderators, and depression and sex as covariates. Participants had their heart rate recorded, cognitive load was introduced, and they completed a series of tasks which included answering questionnaires and completing a measure of overgeneral memory. The influences of these variables on overgeneral memory were then evaluated.

METHOD

Participants

A convenience sample of 319 participants were recruited through the Research Experience Program at The Ohio State University. The Research Experience Program allows undergraduate students who are enrolled in Psych 1100 to gain class credit for participation in research in lieu of writing an essay. This sample was approximately 59% female and approximately 68% Caucasian. Participants self-selected into the study after reviewing the exclusion criteria of not having a prior diagnosis of ADD/ADHD, of having no known allergies to electrode adhesives, and of speaking a language other than English as a primary language. Participants were told that the study was investigating factors which influence cardiovascular health and cognition. Informed consent was obtained from all participants, and all participants were debriefed upon their completion of this study.

Materials and Procedure

The data analyzed for this study were collected in a larger study; the relevant aspects of the design are discussed here. This study examined the association between the experience of trauma and overgeneral memory, as moderated by cognitive load and HRV. This was accomplished by, firstly, recording the participants' HRV using an electrocardiogram. Next, the participants completed questionnaires via computer, and then participants who were randomly assigned to do so underwent the cognitive load manipulation. Lastly, participants completed the Autobiographical Memory Test as a measure of overgeneral memory.

Participants completed the study one at a time, in a small room set up for the various tasks. The experimenter ran the study from an adjoining room, while monitoring participants through a video camera and communicating with participants through an intercom. After providing informed consent, participants had their heart rate recorded via electrocardiogram during a 5-minute baseline period. The participants then completed a set of questionnaires which included measures of depression and experience of trauma. The participants were randomly assigned to the cognitive load condition (i.e., they were instructed to remember a nine digit number during a 15 minute thought monitoring task) or to a no load condition. All participants completed a 15-minute long thought monitoring task prior to the autobiographical memory test. Half of the participants in the load and no load conditions completed a thought suppression period during that task in which they suppressed a seed thought, whereas the other participants merely monitored the occurrence of the seed thought during the task. The experimenter then joined the participant in the study room during the completion of the measure of overgeneral memory.

Heart Rate Variability. Surface electrodes were placed on the participants and their resting heart rate was recorded for five minutes using MindWare 2000D (MW2000D) Impedance Cardiograph package. Kubios software was used to obtain an estimate of the Root Mean Square of the Successive Differences (RMSSD), a measure of parasympathetic nervous system activity. Stronger parasympathetic activity acting on the heart is associated with higher values of RMSSD. The natural logarithms of the RMSSD values were used in this study. Heart rate variability was used as a measure of inhibitory control in this study. During the five minute resting period in which the participants' heart rate was recorded, participants were instructed to sit quietly but to not fall asleep, use their phone, or eat or drink.

The Depression Anxiety Stress Scale (DASS; Lovibond & Lovibond, 1995). The DASS was used as a measure of depression, and assessed levels of depressive symptomatology. It, along with the other questionnaire used in this study, was presented in succession with other questionnaires that were part of a larger research design and that were not analyzed for this current study.

The Life Events Checklist for DSM-5 (Weathers et al., 2013). The Life Events Checklist was used to measure experience of trauma, and looked at 17 possible traumatic life events that participants' could have either experienced themselves, witnessed, heard about, or experience as part of their job. Personal experiences of interpersonal traumatic events were analyzed for this study. This narrowed the possible traumatic events down to 9 interpersonal experiences that could have happened to the participants, as opposed to non-interpersonal traumatic events that they may have witnessed or heard about.

Cognitive Load. Participants were randomly assigned to two different tasks in a 2 x 2 fashion. One of these cognitive load conditions introduced a number memorization task in which the participants were asked to memorize a nine digit number as they were going through questionnaires, and were asked to type this number after each section of the questionnaires. The second cognitive load condition was part of the larger research design and was analyzed in this study after preliminary findings suggested its influence. This second cognitive load condition introduced a thought suppression task which instructed all participants to type in the name of a loved one and imagine that loved one being in a car accident for a 60 second time period. This thought of their loved one being in a car accident was considered the target thought, and the participants later identified the details of their target thought, such as the severity of the car accident they had imagined. Half of the participants were instructed to suppress the target thought for the duration of the task, while the other half of the participants were told that they could think about anything that they would like and were not instructed to suppress the target though. The participants were all instructed to push the "x" key every time the target thought occurred. Participants were randomly assigned to one of four cognitive load conditions in which they either partook in both tasks, in only the number memorization task, in only the thought suppression task, or in neither task.

The minimal instructions Autobiographical Memory Test (*AMT*; Debeer, Hermans, & Raes, 2009). The minimal instructions version of the AMT was created specifically to be a more sensitive measure of overgeneral memory in a nonclinical population (Debeer et al., 2009), and as such was used in this current study on overgeneral memory in a nonclinical population. The AMT used included 12 cue words for which the participants had 60 seconds each to write a memory. The experimenter entered the study room for the duration of the AMT, and instructed participants to turn the page to the next cue word if they had reached the 60 second time limit. The participants also completed a self-evaluation of their memories, rating each memory as either specific, categoric, extended, semantic associate, omission, or other. This study looks at specific versus categorical memories. Four independent coders rated the memories under the same criteria, and inter-rater reliability was confirmed.

Data Analytic Strategy

The hypotheses in this study were tested using regression analyses via the PROCESS utility in SPSS (Hayes, 2013). Analyses looked at number of categorical memories as the dependent variable, and various interactions were considered. A three-way interaction between experience of trauma, HRV, and cognitive load on overgeneral memory was tested. Both HRV and cognitive load were entered as moderators into this regression model, and the two covariates of sex and depressive symptoms were also assessed. To illustrate any interactions involving

HRV, simple slopes were examined at 1 standard deviation (SD) above and below the mean. A follow-up analysis then narrowed down the sample to those included in a double high cognitive load condition versus those in a double no load condition. That is, the subset of participants who were assigned to the cognitive load task and to the thought suppression condition experienced a double cognitive load. In contrast, those assigned to the no load condition and to the non-suppression condition experienced the lowest cognitive load. Consequently, these two groups provided the clearest contrast between a cognitive load versus a control group.

RESULTS

After interrater reliability in the AMT coding was confirmed for specific ($\alpha = .91$) and categoric ($\alpha = .89$) memories, regression analyses were used to test a 3-way interaction between experience of trauma, HRV, and cognitive load on number of categorical memories. As seen in Table 1, a significant three way interaction between experience of trauma, HRV, and cognitive load from the number memorization condition was found, albeit in an overall nonsignificant model. Experience of trauma was not significantly associated with the number of categorical memories at any combination of level of HRV and level of load, but the interaction between experience of trauma and HRV approached significance at both load conditions, suggesting a trend for the trauma by HRV interaction to be associated with more overgeneral memory in the cognitive load condition and less overgeneral memory in the low load condition (B = .476, SE = .285, $p = .096$; B = -.746, SE = .392, $p = .058$). A significant effect for depression on overgeneral memory ($p = .01$) was also noted. Following up on this trend, analyses were ran using only the participants in the highest cognitive load condition and the no cognitive load condition (N =150). As seen in Table 2, these findings were nonsignificant. However, as predicted, it was found that experience of trauma was significantly associated with overgeneral memory only at the highest load and low HRV condition ($p = .020$). As seen in Figure 1, as experience of trauma increases in the high cognitive load condition, overgeneral memory increases in cases of low HRV but stays relatively constant in cases of high HRV (B = -.948, SE = .544, $p = .084$). This same interaction is not seen in the no cognitive load condition (B = .237, SE = .568, $p = .677$).

DISCUSSION

The current study sought to investigate whether the links between experience of trauma in a nonclinical population and overgeneral memory would be made clearer by investigating the moderating impact of inhibitory control or varying levels of cognitive load. As predicted, experience of interpersonal trauma was positively associated with the number of categorical memories, a type of overgeneral memory, under high cognitive load conditions when HRV was low within a nonclinical sample. Consistent with predictions, experience of interpersonal trauma was not significantly related to overgeneral memory on average; that association was moderated by cognitive load and HRV. That is to say, under low cognitive load or high HRV, trauma history and categorical memories were uncorrelated, whereas under high cognitive load or low HRV, trauma history and categorical memories were significantly positively correlated. When constrained to subjects under the highest load condition, a significant relationship between trauma and overgeneral memory was found when HRV was low, such that as experience of trauma increased, so did overgeneral memory in high cognitive load/low HRV individuals. As seen in Figure 1, in individuals with low HRV, the number of categorical memories increased from 1.92 to 3.63 as experience of trauma increased. In comparison, individuals with high HRV showed virtually no change in the number of categorical memories, from 2.95 to 2.98, based on experience of trauma. It is also worth noting that depressive symptoms were significantly associated with overgeneral memory, which both replicates findings of past research and confirms the use of depressive symptoms as a covariate in the present study in order to investigate the unique influence of trauma experience.

Because experience of trauma has not always been predictive of overgeneral autobiographical memory in past research, investigating the factors that interact with experience of trauma to increase overgeneral memory are of considerable importance. This is an area of study that had not been clarified by previous studies (see Sumner, 2012; Williams et al., 2007 for a review), and so these findings provide critical evidence that HRV and cognitive load moderate the relationship between experience of trauma and overgeneral memory. The findings of this current study help to resolve some of the incongruity of past literature on the relationship between experience of trauma and overgeneral memory by providing two moderators that make a notable difference in this relationship. Future research on the association of trauma history and OGM in non-clinical samples should consider individual differences in inhibitory control capacity or use cognitive load manipulations to reveal the association.

Furthermore, these results suggest that there are many factors that influence overgeneral memory, including experience of trauma and depression, and that the interactions between these factors are important to investigate in order to fully understand the phenomenon of overgeneral memory. The results of this current study suggest that HRV was correlated with overgeneral memory, which demonstrates the possibility of using HRV to predict whether or not an individual will experience overgeneral memory after a traumatic experience. This relationship should be further investigated to consider whether or not the appearance of overgeneral memory after a traumatic experience can be predicted by low HRV, and if it can, what possible preventative treatments can be implemented to decrease the occurrence of overgeneral memory in individuals with a history of interpersonal trauma.

Limitations & Future Directions. One limitation to this study that should be considered was that the sample of college students used in this study provided a restricted range of trauma experience. A second limitation was that the effect of cognitive load in this study was only apparent after the more extreme cognitive load condition was considered and post-hoc analyses were run. This first limitation could be addressed by taking a community sample, which would likely provide a better representation of the trauma history of the population at large. Specifically, recruiting participants from low SES neighborhoods would likely provide greater trauma experience. If a college sample were to be used, priority should be placed on obtaining upperclassmen participants in order to provide a larger range of life experience, and therefore a greater likelihood of past trauma history. Future studies should place all participants in the highest cognitive load condition or in the no load condition, thus eliminating the insignificant conditions while better preserving the number of participants in each condition.

In summary, overgeneral autobiographical memory in response to trauma experience in a population not featuring diagnosis of PTSD has not been fully understood, and the findings of this current study help to explain some of the differences in past findings. The links between experience of trauma and overgeneral autobiographical memory in a nonclinical population can be better understood by taking into account the moderating impact of HRV and cognitive load. Results indicate that HRV and cognitive load impact the association between experience of trauma and overgeneral memory such that overgeneral memory increases in individuals with a trauma history when they exhibit low HRV and when placed under high cognitive load. This finding implicates the role of inhibitory control processes in the relationship between experience of trauma and overgeneral memory, and future studies should investigate these relationships further.

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Tables and Figures

Table 1. LEC x HRV x Load Descriptive Statistics.

Variable/ R^2	B (SE)	p
R^2 = .044, p = .153		
Constant	2.264 (.416)	.000
HRV: lnRMSSD	-.024 (.194)	.902
LEC Interpersonal Total	.024 (.157)	.878
LEC x lnRMSSD	-.131 (.241)	.588
Load (Number)	.019 (.241)	.938
LEC x Load	.134 (.308)	.665
lnRMSSD x Load	.311 (.391)	.427
LEC x lnRMSSD x Load	-1.222 (.487)	.013
Sex	.204 (.240)	.395
DASS Depression	.031 (.013)	.013

Note: N = 300; HRV = resting heart rate variability; LEC = life events checklist

Table 2. LEC x HRV x Double Load Descriptive Statistics.

Variable/ R^2	B (SE)	p
R^2 = .051, p = .590		
Constant	2.536 (.600)	.000
HRV: lnRMSSD	.189 (.307)	.539
LEC Interpersonal Total	.212 (.227)	.352
LEC x lnRMSSD	-.363 (.392)	.356
Highest Load	-.006 (.345)	.986
LEC x Double Load	.671 (.442)	.131
lnRMSSD x Double Load	-.034 (.614)	.956
LEC x lnRMSSD x Double Load	-1.185 (.788)	.135
Sex	.170 (.340)	.619
DASS Depression	.008 (.020)	.686

Note: N = 150; HRV = resting heart rate variability; LEC = life events checklist

Figure 1. Trauma and HRV on OGM.